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(54) LOCK POSITION SENSING

(57) A method includes reading data from a proximity switch and calculating an inductance value from a solenoid, the proximity switch and solenoid located in or around a lock, and processing the data from the proximity switch and the inductance value. The method further includes comparing the processed data with an expected value to confirm the lock status.

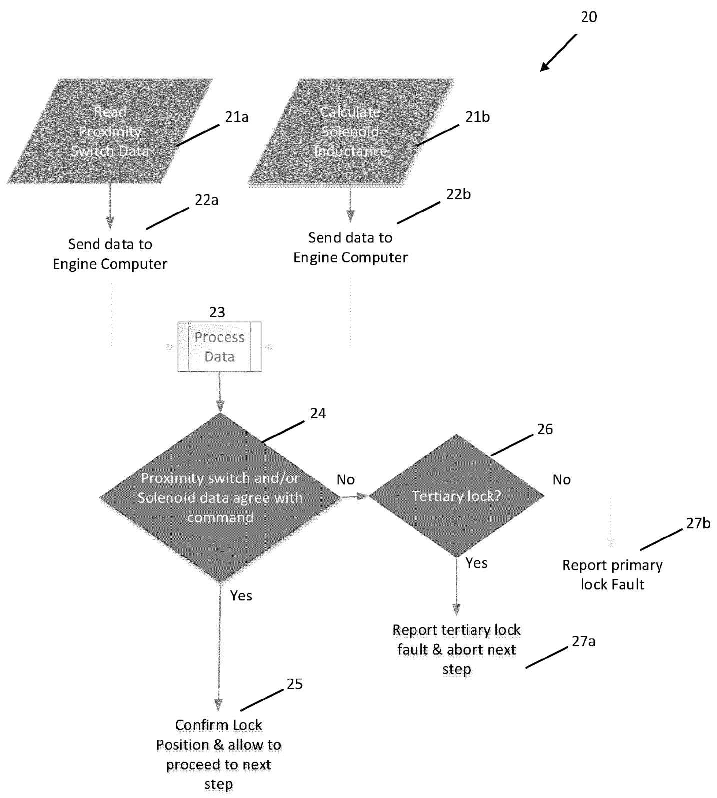

Figure 2

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Description

TECHNICAL FIELD

[0001] The present disclosure relates to lock position sensing. In particular, the present disclosure relates to thrust reverser lock position sensing.

BACKGROUND

[0002] Lock position sensing is ordinarily carried out by providing proximity switches in order to sense the positions of mechanical locks. Typically, there are three mechanical locks per thrust reverser actuation system, with two proximity switches allocated to each lock for sensing the positions of each lock.

SUMMARY OF THE INVENTION

[0003] In one aspect, there is provided a method that includes reading data from a proximity switch and calculating an inductance value from a solenoid, the proximity switch and solenoid located in or around a lock, and processing the data from the proximity switch and the inductance value. The method further includes comparing the processed data with an expected value to confirm the lock status.

[0004] The lock may comprise a primary lock and a tertiary lock. The method may also further comprise determining if the lock is in an unlocked position, and, if it is determined that the lock is in an unlocked position, the method proceeds to a next stage of flight.

[0005] Further, if it is determined that the lock is not in an unlocked position, the method may further comprise determining whether the tertiary lock or the primary lock is unlocked. If it is determined that the tertiary lock is locked, the method may not proceed to the next stage of flight. If it is determined that the primary lock is locked, the method may further comprise reporting a primary lock fault.

[0006] The next stage of flight may be deploying a thrust reverser actuation system.

[0007] In another aspect, there is provided a method that includes calculating a first inductance value of a primary solenoid and calculating a second inductance value of a secondary solenoid, said primary and secondary solenoids located in or around a lock, and processing the first inductance value and the second inductance value. The method further includes comparing the processed values with an expected value to confirm the lock status.

[0008] The lock may comprise a primary lock and a tertiary lock. The method may also further comprise determining if the lock is in an unlocked position, and, if it is determined that the lock is in an unlocked position, the method proceeds to a next stage of flight.

[0009] Further, if it is determined that the lock is not in an unlocked position, the method may further comprise determining whether the tertiary lock or the primary lock is unlocked. If it is determined that the tertiary lock is locked, the method may not proceed to the next stage of flight. If it is determined that the primary lock is locked, the method may further comprise reporting a primary lock fault.

[0010] The next stage of flight may be deploying a thrust reverser actuation system.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

Figure 1 shows a conventional method of sensing lock positions.

Figure 2 shows a new proposed method of sensing lock positions.

Figure 3 shows a further new method of sensing lock positions.

DETAILED DESCRIPTION

[0012] Figure 1 shows an example of a method for sensing the lock position. The general flow chart 10 is shown in Figure 1. As an example, the method includes reading proximity switch data from a first proximity switch, as shown at step 101a. The method also reads proximity switch data from a second proximity switch, as shown at step 101b. The proximity switches are located around the tertiary lock and primary lock to indicate when the lock is in locked or unlocked position. For example, there may be proximity switches located around a lock that includes the tertiary lock and the primary lock, or there may be provided proximity switches around the tertiary lock and then further proximity switches around the primary lock.

[0013] At step 102a, the data from step 101a is sent to the engine computer. At step 102b, the data from step 101b is also sent to the engine computer. The data is then processed at step 103. At step 104, the processed data is compared with a lock command to ascertain whether the lock is in an expected position. If the proximity switches determine that the tertiary lock is in an unlocked position, step 105 confirms that the tertiary lock is in an unlocked position and the engine computer can move on the next step of flight. If the data from the proximity switches determine that the tertiary lock is not in an unlocked position, step 107a reports a fault in the tertiary lock and the engine computer does not move on to the next step.

[0014] For example, step 103 processes the data sent to the engine computer from steps 102a and 102b to compare the sensors data and determine the status of the primary and tertiary locks. If it is determined that the proximity switches data is showing that the locks are in an unlocked position then the engine computer may proceed with the next stage of flight, as shown at step 105.

If it is determined that the data comparing the lock status differ then stage 106 determines whether the difference of proximity switch data is linked to the tertiary lock as shown in step 106. If it is the case then a tertiary lock fault is reported and the next step of the thrust reverser actuation system functionality which consists of a deploy is aborted as shown in step 107a. If the tertiary lock proximity switch data does not differ and the difference in proximity switch data is associated with the primary lock then a primary lock fault failure is reported at step 107b.

[0015] A method for lock position sensing, according to this disclosure, is shown in Figure 2. A general flow chart 20 is shown in Figure 2. As an example, the method includes reading a single proximity switch that is located in the system at step 21a. Therefore, in this example method, there is only one proximity switch provided at or around a lock. The lock may include a tertiary lock and a primary lock. The method may also include calculating a solenoid inductance of a solenoid provided in or around the lock at step 21b. At step 22a, the data read by step 21a is sent to the engine computer. At step 22b, the solenoid inductance calculated at step 21b is sent to the engine computer. Step 23 processes the data sent to the engine computer from steps 22a and 22b to compare the data with values to determine whether the lock is unlocked at step 24. If it is determined that the proximity switch and/or the solenoid inductance show that the lock is unlocked, it is confirmed that the tertiary lock is unlocked and the engine computer may proceed with the next stage of flight (for example, deployment of the thrust reverser actuation system), as shown at step 25. If it is determined that the lock is in a locked position, the method then determines whether the tertiary lock or the primary lock is unlocked. If it is determined that the tertiary lock is not unlocked then a fault is reported at step 27a and the engine computer does not proceed to the next stage of flight (for example, the engine computer does not proceed to deployment of the thrust reverser actuation system). If it is determined that the primary lock is locked, the method at step 27b reports that there must be a primary lock fault.

[0016] An alternative method for lock position sensing, according to this disclosure, is shown in Figure 3. A general flow chart 30 is shown in Figure 3. As an example, the method includes calculating an inductance value from a primary solenoid located in the system at step 31a. Therefore, in this example method, there are no proximity switches. The method may also include calculating an inductance value of a secondary solenoid provided in or around the lock at step 31b or a secondary coil located in the proximity of the primary coil. The lock may include a primary lock and a tertiary lock. At step 32a, the primary solenoid inductance value is sent to the engine computer at step 31a. At step 32b, the secondary solenoid inductance value calculated at step 31b is sent to the engine computer. Step 33 processes the inductance values sent to the engine computer from steps 32a and 32b to compare the values to determine the lock position at step 34. If it is determined that the primary solenoid inductance value and/or the secondary solenoid inductance value show that the lock is unlocked , it is confirmed that the tertiary lock is unlocked and the engine computer may proceed with the next stage of flight (for example, deployment of the thrust reverser actuation system), as shown in step 35. If it is determined that the lock is not in an unlocked position, the method then determines whether the tertiary lock or the primary lock is unlocked . If it is determined that the tertiary lock is locked , then a fault is reported at step 37a and the engine computer does not proceed to the next stage of flight (for example, the engine computer does not proceed to deployment of the thrust reverser actuation system). If it is determined that the primary lock is locked , the method at step 37b reports that there must be a primary lock fault.

[0017] Although this disclosure has been described in terms of preferred examples, it should be understood that these examples are illustrative only and that the claims are not limited to those examples. Those skilled in the art will be able to make modifications and alternatives in view of the disclosure which are contemplated as falling within the scope of the appended claims.

Claims

1. A method comprising:

    reading data from a proximity switch and calculating an inductance value from a solenoid, the proximity switch and solenoid located in or around a lock;
    processing the data from the proximity switch and the inductance value;
    comparing the processed data with an expected value to confirm the lock status .

2. The method of claim 1, wherein the lock comprises a primary lock and a tertiary lock.

3. The method of claim 2, wherein the method further comprises determining if the lock is in an unlocked position, and, if it is determined that the lock is in an unlocked position, the method proceeds to a next stage of flight.

4. The method of claim 3, wherein, if it is determined that the lock is not in an unlocked position, the method further comprises determining whether the tertiary lock or the primary lock is unlocked.

5. The method of claim 4, wherein, if it is determined that the tertiary lock is locked, the method does not proceed to the next stage of flight.

6. The method of claim 4, wherein, if it is determined that the primary lock is locked, the method further

comprises reporting a primary lock fault.

7. The method of any of claims 3 to 6, wherein the next stage of flight is deploying a thrust reverser actuation system.

8. A method comprising:

   calculating a first inductance value of a primary solenoid and calculating a second inductance value of a secondary solenoid, said primary and secondary solenoids located in or around a lock;
   processing the first inductance value and the second inductance value;
   comparing the processed values with an expected value to confirm the lock status.

9. The method of claim 8, wherein the lock comprises a primary lock and a tertiary lock.

10. The method of claim 9, wherein the method further comprises determining if the lock is in an unlocked position, and, if it is determined that the lock is in an unlocked position, the method proceeds to a next stage of flight.

11. The method of claim 10, wherein, if it is determined that the lock is not in an unlocked position, the method further comprises determining whether the tertiary lock or the primary lock is unlocked.

12. The method of claim 11, wherein, if it is determined that the tertiary lock is locked, the method does not proceed to the next stage of flight.

13. The method of claim 11, wherein, if it is determined that the primary lock is locked, the method further comprises reporting a primary lock fault.

14. The method of any of claims 10 to 13, wherein the next stage of flight is deploying a thrust reverser actuation system.

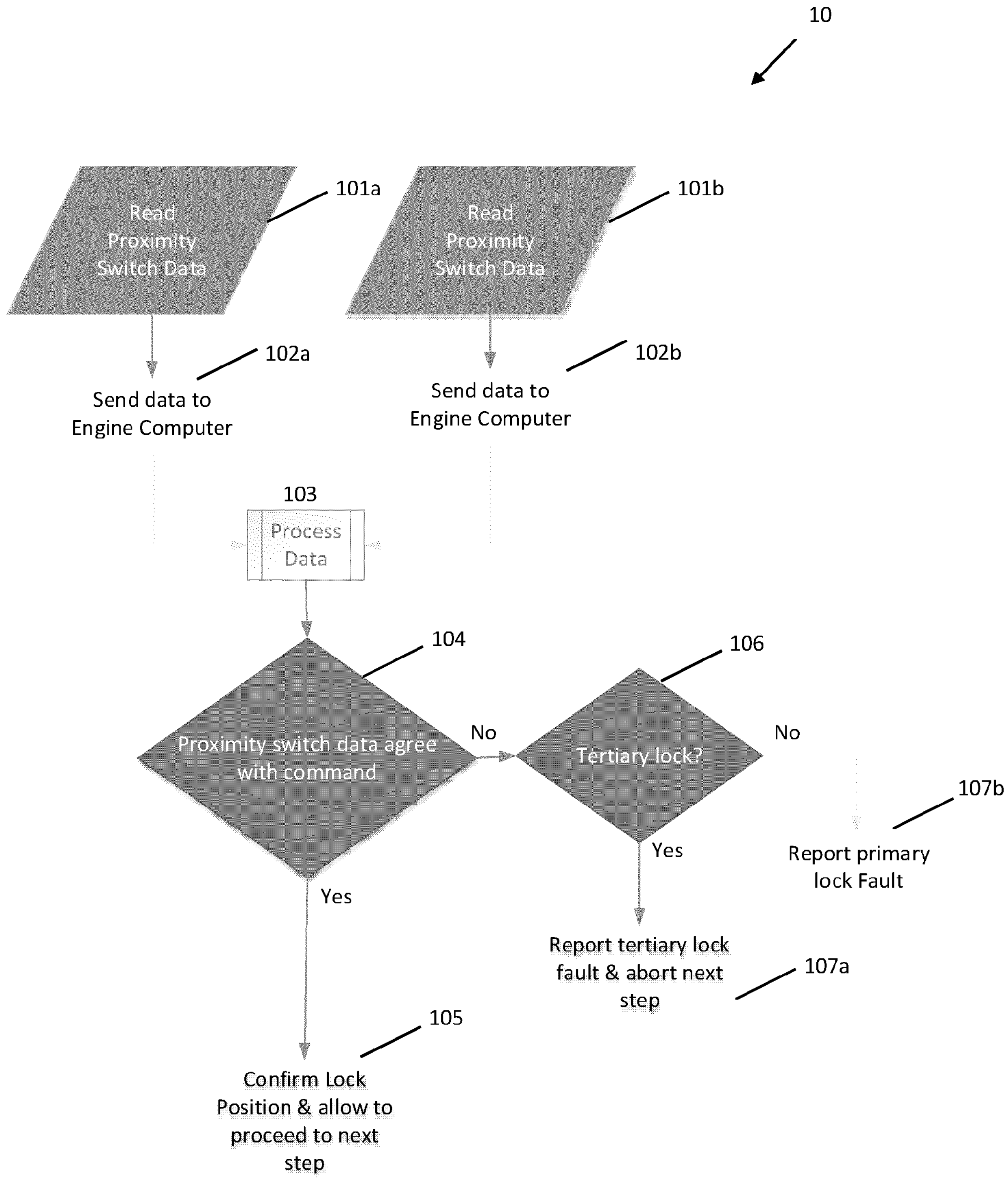
10
Read Proximity Switch Data
101a
Read Proximity Switch Data
101b
102a
Send data to Engine Computer
102b
Send data to Engine Computer
103
Process Data
104
Proximity switch data agree with command
No
106
Tertiary lock?
No
107b
Report primary lock Fault
Yes
Report tertiary lock fault & abort next step
107a
Yes
105
Confirm Lock Position & allow to proceed to next step

FIGURE 1

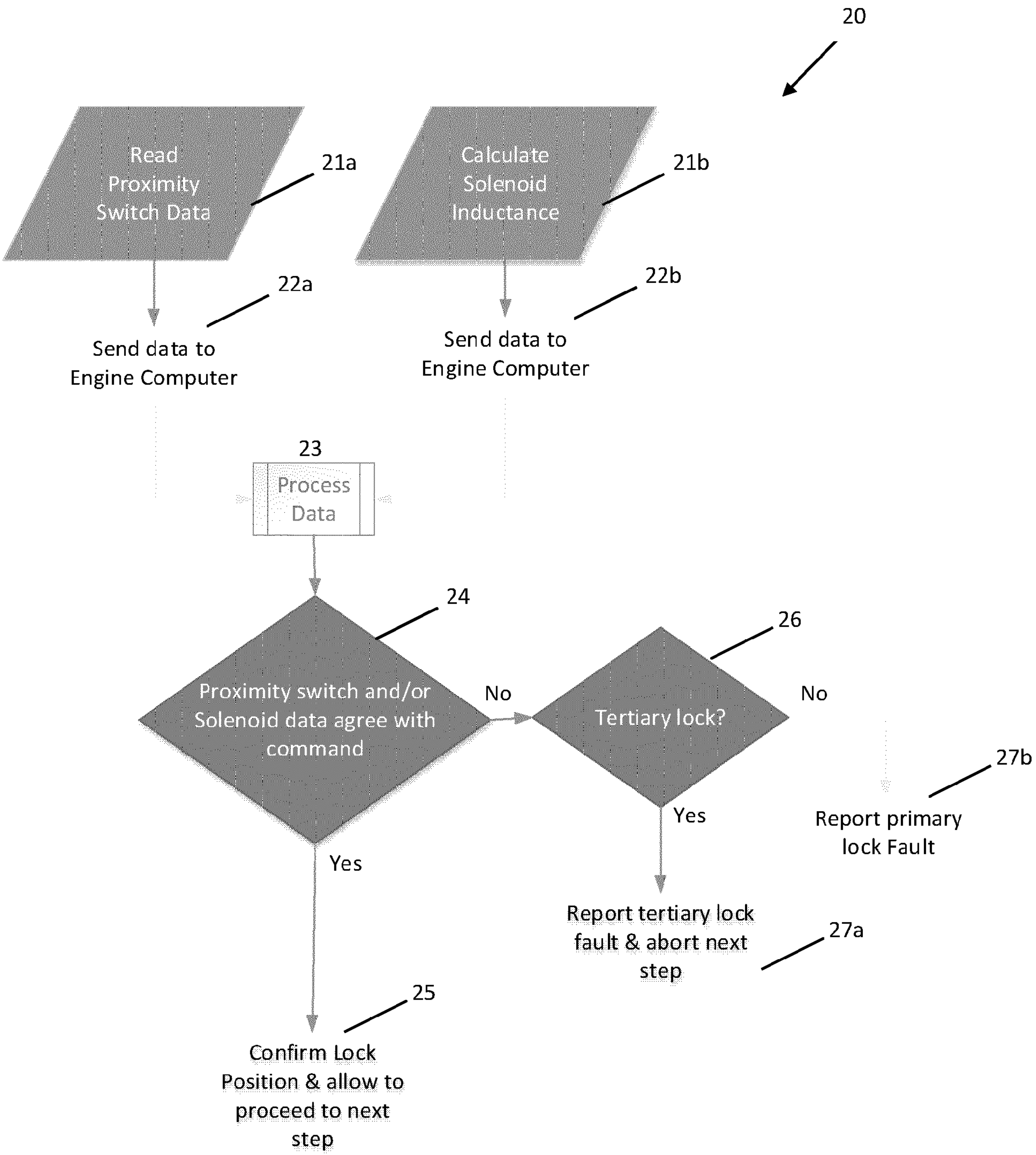
20
Read Proximity Switch Data
21a
Calculate Solenoid Inductance
21b
22a
Send data to Engine Computer
22b
Send data to Engine Computer
23
Process Data
24
Proximity switch and/or Solenoid data agree with command
No
26
Tertiary lock?
No
Yes
27b
Report primary lock Fault
Yes
Report tertiary lock fault & abort next step
27a
25
Confirm Lock Position & allow to proceed to next step

Figure 2

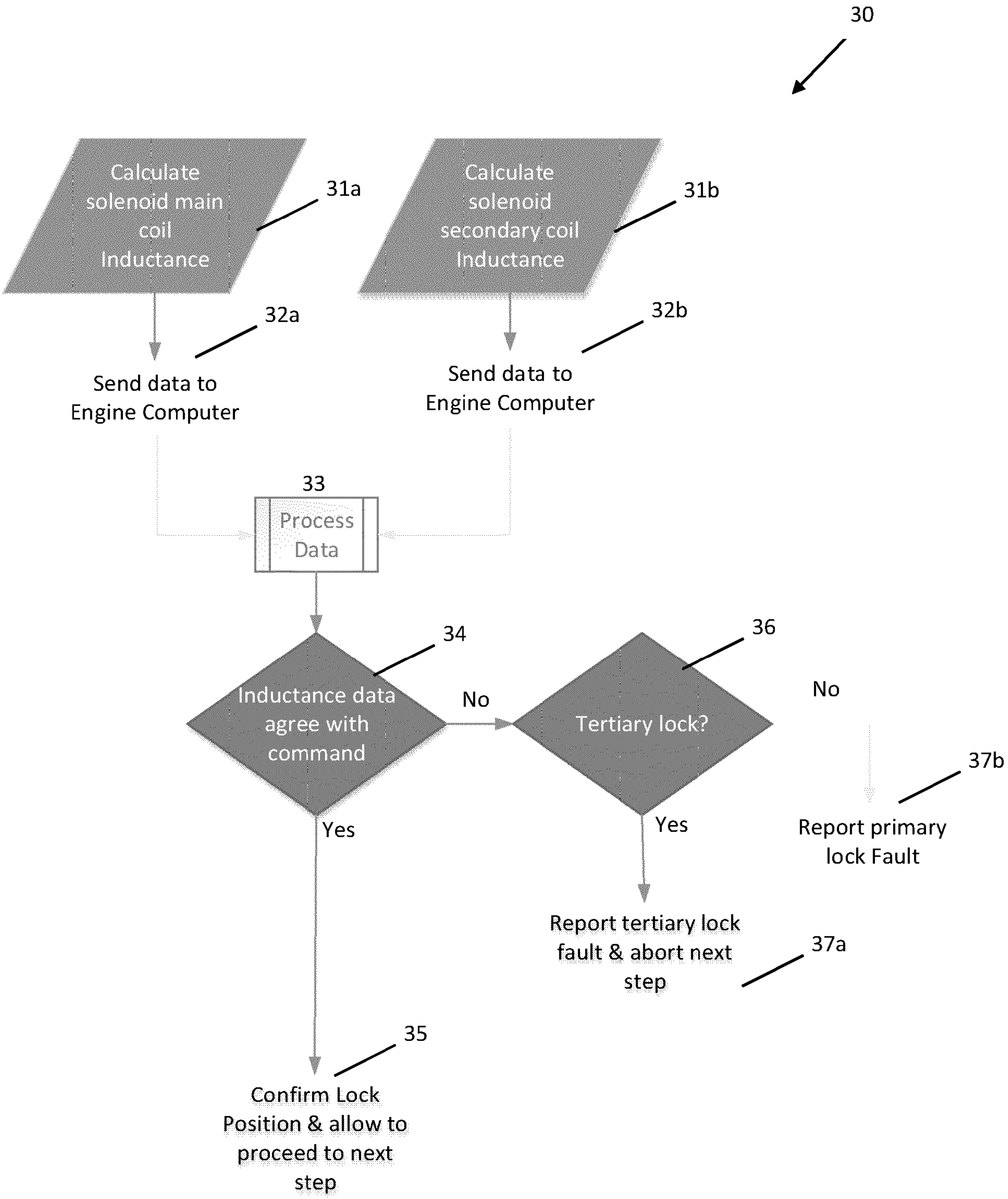
30
Calculate solenoid main coil Inductance
31a
Calculate solenoid secondary coil Inductance
31b
32a
Send data to Engine Computer
32b
Send data to Engine Computer
33
Process Data
34
Inductance data agree with command
No
36
Tertiary lock?
No
37b
Yes
Yes
Report primary lock Fault
Report tertiary lock fault & abort next step
37a
35
Confirm Lock Position & allow to proceed to next step

FIGURE 3

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EUROPEAN SEARCH REPORT

Application Number
EP 21 27 5154

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 10 914 267 B2 (SAFRAN AIRCRAFT ENGINES [FR]) 9 February 2021 (2021-02-09) * figure 15 * * column 12, line 56 - line 59 * -----	1-5, 7-12,14	INV. F02K1/76
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X	EP 1 043 492 A2 (LUCAS INDUSTRIES LTD [GB]) 11 October 2000 (2000-10-11) * figures * -----	1	

TECHNICAL FIELDS SEARCHED (IPC)

F02K

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	31 March 2022	Angelucci, Stefano

CATEGORY OF CITED DOCUMENTS

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